

Dental caries in South Pacific populations: A review

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Abstract: Dental caries (tooth decay) was uncommon in Pacific Island communities before European trading and migration expanded into the Region. The etiology of this oral microbial disease is a consequence of changed diets, food preparation and lifestyle. In particular, the easy availability of a high level of frequent dietary supplementation with refined sucrose (sugar) and carbohydrates is the key factor in the etiology of tooth decay. While tooth decay initially developed as a health problem in the more accessible Pacific islands over a century ago, it has spread increasingly as trading, travel and cash economies have developed to include even the more geographically remote communities. In this review selected epidemiological data are presented to show the magnitude, variation and secular changes in the prevalence of tooth decay in different communities. Tooth decay in conjunction with the historically endemic adult gum diseases poses a major public health problem in terms of pain, premature loss of teeth and the need for oral rehabilitation. Implementation and monitoring of caries control programs is a priority need in most communities. It is impractical to consider a return to indigenous diets and lifestyles as a strategy for caries prevention. Instead promotion of proven modern community preventive programmes, notably appropriate use of fluorides, 'fissure sealants' together with control of excessive consumption of diets rich in refined sugar is required if a significant increase in the levels of tooth decay is to be avoided. (PHD, 2003; 10 (1), Pages 62-67)

Introduction

Dental caries (tooth decay) is a widespread, non-communicable disease of teeth. Its initial pathology commences as an acid dissolution of the hard outer tooth enamel followed by progressive penetration of microorganisms into the deeper tissue (dentine) until the pulp of the tooth is exposed. Active or untreated decay into dentine is associated with severe pain, infection and destruction of the tooth pulp, abscess formation, infection of the supporting bone, and possibility of systemic ill health.

Until the turn of the 19th century the enviable quality of teeth of island peoples were praised by explorers and traders because of the attractiveness of even rows of immaculate white teeth retained into old age.¹ Various reports of tooth decay in Pacific Island communities in the pre-European era generally identify it as of a low prevalence.^{2,3} Apart from decay of root surfaces and occlusal fissure caries reported in pre-historic and indigenous communities, the extensive smooth surface caries responsible for the past rampant tooth decay in the 'western' countries, was unknown in the Pacific region. This was attributed to the quality of the traditional regional natural diets and lifestyle.^{3,4}

While sucrose (sugar) is commonly assumed to have followed European trading and migration, however sugar cane was a recognized as a local plant, noted for its sweetness, in earlier centuries. Nevertheless it was the entry of processed refined sugar and other dietary changes introduced through European trading and migration, rather than crude sugar cane, which was responsible for the increasing epidemic of tooth decay in the Region.⁵

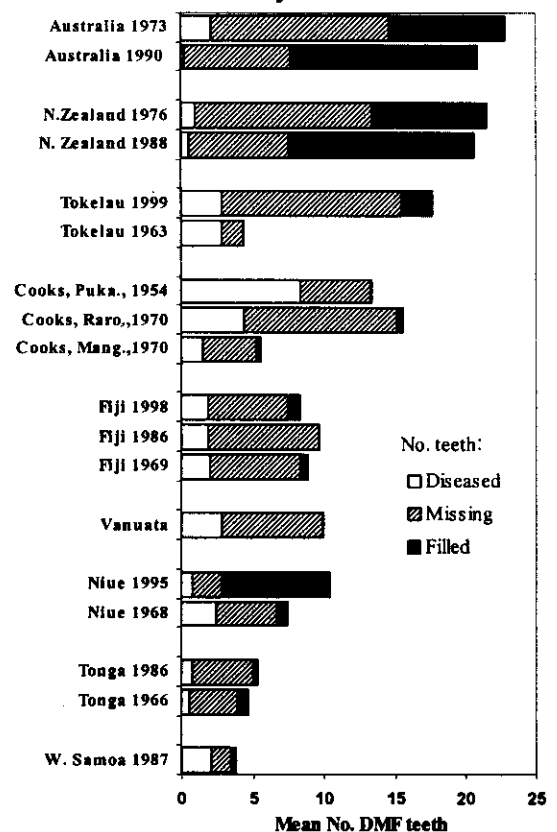
Sugar is now available to most South Pacific communities either as a refined product or in processed store foods or both. Its sweetness, value in preserving fruits and in cooking has made it an integral feature of community diets over the past century. It, and possibly other refined carbohydrates, are the dietary items most associated with the increase in tooth decay as a public health problem. Indigenous lifestyles, particularly diet, are changing even

in remote communities as travel, migration and trading become routine activities. Use of sugar, in 'western' diets is pervasive in many commercial and processed foods, in general food preparation, as table (refined) sugar, tinned milk, preserves, confectionery products and sugar based beverages.

Prevalence of tooth decay

Many inter- and intra-country studies have reported variations in prevalence and severity of caries and changes with time. Figure 1 presents some epidemiological data for tooth decay prevalence in 35-45 yr.-olds. At this age the measure of prevalence, i.e. the mean number of diseased,

Fig. 1. Inter Country comparison of DMF teeth scores, 35-44 yr-olds



missing and filled (D, M, F) teeth is primarily explained by tooth decay, only in later years does gum disease become a significant cause of M teeth.

DMF profiles of the main trading islands such as, Tahiti, Fiji and Cook Islands long ago followed the oral health profiles of New Zealand and other western -type populations countries as they adopted dietary and life-style changes. Present day communities with low tooth decay levels are mostly those where geographic isolation has restricted or slowed access to tooth decay caries inducing foods. Previously remote communities such Tonga, Tokelau, and Niue escaped the impact of changed diets on their health but the barriers to change have mostly gone. New Zealand and Australian populations show the highest numbers of DMF teeth in the Region resulting from their traditional exposure to very high intakes of refined sugars. The magnitude of their past dental health problems demonstrates the potential 'dental disaster' awaiting other South Pacific communities unless control measures now used in those two populations are implemented.

Country profiles

The following country profiles from specific communities provide sufficient data to identify their respective prevalence and severity of tooth decay and hence the magnitude of dental 'needs'. All the data in studies in this report are based on the numbers of diseased (D), missing (M) and filled (F) teeth - commonly referred to as the DMF tooth index. While much of the data is historical it provides an overall picture of tooth decay levels and some changes in the Region.

Early childhood caries (ECC) also known as 'nursing or baby bottle' decay defines a characteristic rampant decay in children 3 years and younger, it appears an increasing phenomenon worldwide.

Information on tooth decay of deciduous (primary) teeth is relatively uncommon but some information is provided. Early childhood caries (ECC) also known as 'nursing or baby bottle' decay defines a characteristic rampant decay in children 3 years and younger, it appears an increasing phenomenon worldwide.⁸ While epidemiological data on ECC in the South Pacific is not documented it is a well-known increasing clinical problem in many island communities. It poses serious clinical, management and socioeconomic problems.

American Samoa

A 1950 study⁷ described oral conditions of 6-34 yr-olds on the islands of Tutuila and Manu'a; the average number and percentage of decayed teeth was low, between 1.9-2.8 and 1.4-5.1 respectively.

The author⁷ made interesting comments on the increased prevalence of tooth decay and possible related environmental factors since the 1930's, particularly with respect to the traditional culture (Fa'a Samoa) and the transition to European influences on lifestyles. For example, he observed that variation in DMF scores was unrelated to fluoride levels in drinking water but was associated with the villager's access to store foods. A comparison of dietary changes between the 1930's and

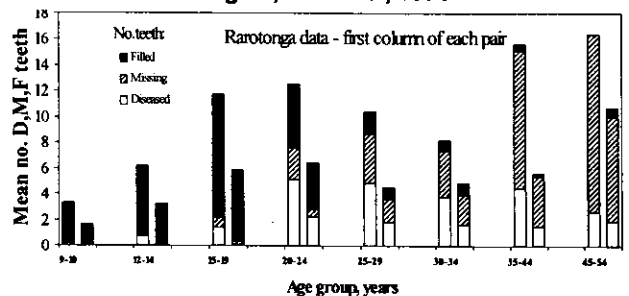
1950's showed that in 1930 only 10% of calorific energy was obtained from foods purchased in stores, whereas in 1950 this had increased to 21%. Dietary data revealed that per capita sugar consumption increased 3-fold over the 20-year period, reaching a level much in excess of the suggested caries risk level of 18 kg per capita.⁸ In another study⁹ the caries prevalence in 3-21 yr-olds varied between urban, moderately isolated, remote and isolated communities at 73%, 60%, 42%, and 22% respectively.

Cook Islands

The oral conditions of this population have, during the past century, closely followed the pattern in New Zealand, which is no doubt explained by their close affiliation in trade, social, and health care systems (including a school dental service).

Extensive dental data was collected¹⁰ in 1970's on the dental conditions of 5-74 yr-olds (Figure 2). Both moderate and low prevalence of tooth decay was reported - depending on island locality. In Rarotonga 12% and 100% of 5 and 15 yr-old children respectively had experienced tooth decay and 19 yr-olds averaged more than 10 DMF teeth. Older adults had lower DMF scores - indicating an increased caries risk in the younger generations. By contrast in Mangaia, caries experience was lower, between 0% and 89% for 5 and 15 yr-olds respectively. DMF scores, for comparable age groups, were almost 50% lower than in Rarotonga with 19 yr-olds averaging less than 6 DMF teeth. As in Rarotonga, adults over 24 years showed lower DMF scores, again evidence of increased decay caries risk in the younger generations.

Fig. 2. Comparison of no. D,M,F teeth, Rarotonga and Mangaia, Cook IIs., 1970



The high levels of M teeth in older adults (>45 yrs) in both islands is disproportionate to caries prevalence and best explained as a consequence of gum disease. Diet was not, in the author's opinion, the explanation of the inter-island caries differences. Instead he speculated either on a soil or a possible genetic factor.

An anthropological study in 1989¹¹ reported on the dental health of 10-20 yr-olds in the three main island groups. More than 92% of subjects had experienced 5-8 DMF teeth, scores similar to those noted in 1970.¹⁰ They referenced two palaeontological studies of peoples in the Region prior to the European era, which revealed no

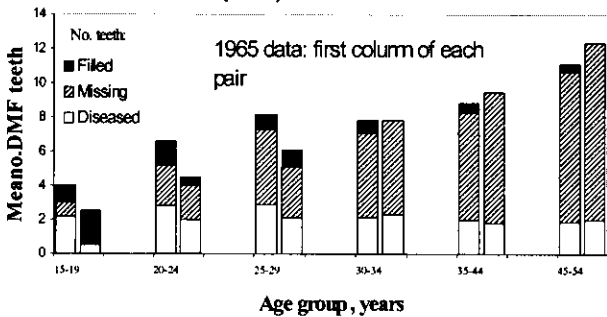
evidence of any tooth decay. They were also of the opinion that tooth decay problems entered the Pacific island communities with the progressive adoption of western / European foods and food preparation.

Fiji

Like the Cook Islands and French Polynesia, Fiji was one of the earliest communities to experience lifestyle changes associated with European trading and settlement in the past centuries and second world war. A 1965 survey¹² of 3-54 yr-olds provided the first data on oral conditions of the population. Prevalence of decay was summarized as 'moderate' but a significant tooth loss (M teeth) occurred by middle age. Differences in decay levels were evident between indigenous Fijian and Indian Fijian populations.

Deciduous tooth decay was reported for 20-25% of Fijians with Indian Fijian children being more affected. Caries experience (one or more teeth) of permanent teeth increased rapidly from 30% of young children to almost 100% of young adults. Twenty years later, a further national survey¹³ in 1985 reported no significant ethnic differences between indigenous and Indian Fijians although regional variations in caries levels were reported. Compared with 1966 DMF tooth scores, caries prevalence were similar or lower for children and young adults (Figure 3). While the mean number of DMF teeth was low for children, levels increased with age, with almost 12 DMF teeth affected by age 50 years with M teeth being the major component.

Fig. 3. Comparison of mean no. DMF teeth, Fiji 1965 (first) and 1986



An inter-island nation study¹⁴ of possible associations between tooth decay, fluoride and sugar availability, reported low mean DMF scores of only 0.5 and 1.6 for 11 yr-old urban and rural Fijians respectively - also little changed from that reported in 1969.¹² A 1980 report¹⁵ provided caries data for 1056 children from rural regions, which revealed a worsening trend. The proportion of 14 yr-olds experiencing decay had risen, compared to 1965, from 65 to 82% with mean DMF scores between 2.5 and 3.3, with urban communities and indigenous Fijians with more decay than Indian Fijians.

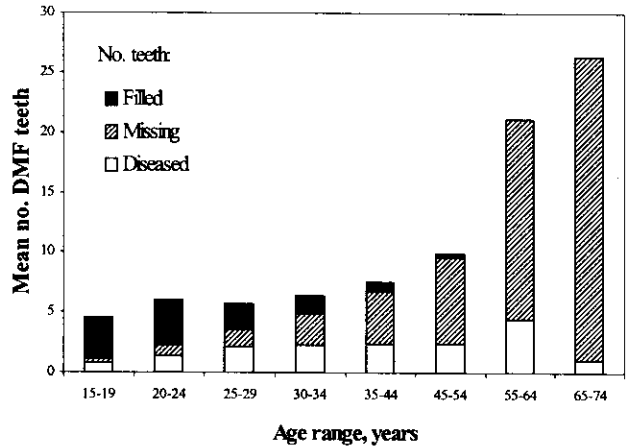
The dental health-care system in Fiji has primarily targeted pain relief and curative treatments although during the past 20 years caries preventive programmes have been implemented, including water fluoridation, fluoride mouth rinsing, fluoride tooth pastes, fissure sealants and community dental health education.

Niue

A comprehensive cross-sectional survey of dental health across all age groups in 1968 provided a thorough profile

on a remote island community.¹⁶ 11- 44 yr-olds averaged DMF scores of 3 to 8 respectively (Figure 4). Thereafter, for 50-60 yr-olds, the DMF scores increased rapidly to a

Fig. 4. Mean no. DMF teeth, Niue, 1968



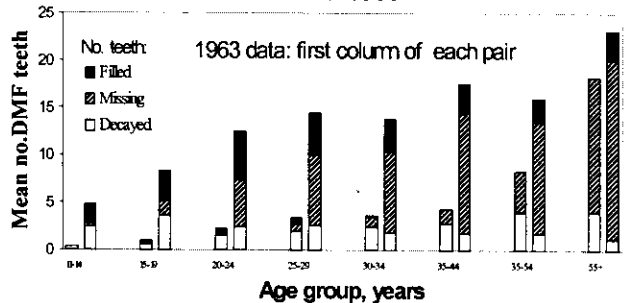
mean of 25 teeth mostly explained by M teeth - a consequence of gum disease rather than tooth decay.

Tokelau

A comprehensive cross-sectional report on oral health across all age groups was carried out in the 1960's.¹⁷ Figure 5 shows the DMF scores for virtually the whole 1677 child and adult inhabitants of the three atolls. While DMF scores were lower than in Niue, both communities show oral health profiles typical of geographically isolated communities with retained indigenous lifestyles, cultures and diets. While the number of missing teeth increases after age 45 years due to gum disease, it appears that even into old age the average number of decayed teeth did not exceed 4. In 1999 an *ad hoc* survey of 500 subjects from the three atolls revealed a much-changed oral health profile.¹⁸

Comparison of the 1963 and 1999 data (Figure 5) showed that a significant deterioration in oral health had occurred

Fig 5. Comparison of mean no. DMF teeth, Tokelau, 1963 and 1999



over 30 years. Untreated decayed and filled teeth had increased significantly - with tooth loss a significant feature even for young adults. Between 62 - 82% of 4-10 yr-old children in the 1999 survey had one or more decayed deciduous teeth. Few of the decayed teeth had been treated; also an early childhood tooth decay pattern was noted in children <5yrs. The magnitude of deterioration in oral health in this community should be viewed as a 'warning' of the potential for significant increases in tooth decay in many other communities in the Region.

Tonga

Two large national surveys 20 years apart, 1966¹⁹ and 1986²⁰, provide valuable profiles on the level of tooth decay of deciduous and permanent teeth (Figures 6, 7). Both surveys included more than 10,000 children and adults. Decay levels of permanent teeth were low and almost identical in both surveys, at all ages.²¹ The increased number of M teeth after age 35 years is explained by the prevailing endemic chronic gum disease - which is evident from young adulthood onwards. Although data for adults 55 years and older was not available from the 1966 survey the report on 1986 showed a continued substantial increase in M teeth - almost 50% of teeth were missing by age 64.

Despite the relatively low levels of tooth decay maintained over 20 years there were, nevertheless, signs of an increased caries challenge evident for both deciduous permanent teeth (Figure 6).²¹ National diet changes are evident including increased sugar consumption. A smaller

Fig. 6. Comparison of mean no. dmf deciduous teeth, Tonga, 1966 and 1986



1981 survey²² identified signs of increased caries levels in children, which was later supported by the findings of the 1986 national survey.

Western Samoa

Data on tooth decay and tooth loss are available from several sources. A 1974 report²³ on DMF levels in Manono-tai reported low tooth decay levels. More recent data obtained in a WHO survey (1987) showed that 82% of 20 yr-olds had, on average, experienced 4 DMF teeth, a level higher than in previous generations and indicative of an increasing caries problem. A substantial increase in DMF in adults 45 years and older is explained almost totally by M teeth, missing because of endemic gum disease.

Comparison with the Tongan community shows a similar DMF profile until age 45 years but lower DMF scores, age for age, than in the Tonga community.²²

Decay of tooth root surfaces

Decay of the root surfaces is dependent on the exposure of root surfaces to the oral microorganisms as a consequence of gum disease. Its etiology is similar to tooth crown decay, in this case demineralization of the dentine. Heavy deposits of dental plaque and calculus frequently obscure even advanced root decay in these

communities. The prevalence, interrelationships and clinical criteria of root decay was described for a Papuan New Guinea community.^{24,25} Likewise the 1982 surveys²² in Tonga and W. Samoa reported extensive root decay identified mostly from radiographic evidence.

Historically it preceded European-type tooth decay. Examination of skulls of Hawaiian Polynesians² observed that root surface caries was common in pre-European times. The prevalence was reported at 48% of 26-40 yr-olds and 68% of 40+yr-olds. The authors referenced other publications on root decay in other ancient populations. Surprisingly no comment was made on gum disease as an etiological factor.

Discussion

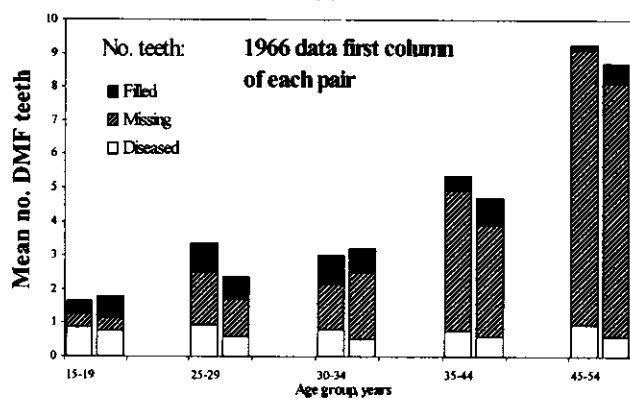
Most nations in the Region have, over the past 30 years, accumulated information on the magnitude of their national dental problems. Evaluation of the profiles revealed significant geographical differences within and between island nations. Compared with DMF scores in Australia and New Zealand (Figure 1) the island nations experienced low to moderate tooth decay scores. However the move to 'urbanization' of island communities exposed them increasingly to lifestyles that were responsible for very high levels of tooth decay in Australian and New Zealand populations. Both those countries found it necessary to acknowledge it as public health problem. It required a massive implementation of dental care treatment, preventive programmes and associated facilities to deal with the problem. It is unlikely that such resources will be available to island nations.

Data from repeated surveys in Fiji, Tonga and Tokelau show interesting features. The Tongan profiles were very similar with a maintained low caries risk. Fiji, although with a higher caries, also showed little change over the years, in fact possible decreased risk for the younger generations. Tokelau on the other hand shows a startling

deterioration over 36 years. Its DMF scores were as good if not better than Tonga in the 1960's. There must be concern that this level of deterioration might be a trend in other South Pacific communities. Regular monitoring of DMF levels in children and teenagers would be useful for identifying impending worsening in oral health as the indigenous lifestyle change.

Common to all data profiles is the increase in the numbers of M teeth in the fifth decade of life in both low and high caries populations. Even complete loss of natural teeth (edentulism) is quite common in the Region from age 45 years and later. For example, data from the low caries Tongan population revealed that in 1986 5-6% were without natural teeth (edentulous) by age 54 years, with a further 10% needing complete extraction of their remaining teeth. By age 64 years edentulism had risen to about 20% with a further 20% needing total extractions (Figure 7). Lack of facilities and cost excludes many communities from rehabilitation with dentures, with consequent disadvantages of decreased oral efficiency, restricted dietary choices and general diminution of lifestyles.

Fig. 7. Comparison of DMF teeth, Tonga 1966 and 1986



Diet has long been recognized as being the most important factor in the etiology of tooth decay. From the evidence, the indigenous diets in the South Pacific were not a risk for tooth decay. Unfortunately, worldwide experience shows that it is unrealistic for communities to revert to indigenous diets as a means of lowering their decay risks. In particular an increased widespread use of processed sugar and foods throughout the Region appears inevitable. The options for control of the tooth decay problem are limited but effective. They include use of fluoride decay preventive programmes, educational programmes to improve population knowledge levels on the causes of poor dental health, and community and governmental initiatives to restrict dietary amounts and frequency of use of high sugar products.

From the evidence, the indigenous diets in the South Pacific were not a risk for tooth decay.

Annual sugar intakes above 18-20 kg pose an increasing risk for tooth decay in the South Pacific countries as the nutritional transition commonly incorporates a per capita sugar consumption well excess of the critical 20kg⁸. Regional examples of populations where an apparent cause-and-effect was evident between sugar exposure and high levels of tooth decay were N. Caledonia, Tahiti, Fiji, Cook Is., New Zealand and Australia. Increased tooth decay problems of many other communities such as PNG, Tonga and W. Samoa can be predicted as they transit to Western dietary patterns, if caries control programmes are not introduced. The WHO recently reported²⁶ on the emerging worldwide health problems related to diets. Tooth decay is one of several widespread health problems predicted to increase with the trends in changed diets and associated lifestyles.

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Adam and Eve had many advantages, but the principal one was
that they escaped teething
(Mark Twain in *The Tragedy of Pudd'nhead Wilson*)